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THE EXTERNAL MORPHOLOGY OF *LACHNOSTERNA*
CRASSISSIMA BLANCH
(Scarabæidæ, Coleop.)¹

By

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INTRODUCTION

The present discussion of the external features of *Lachnosterna crassissima* Blanch. is offered to supply the lack of an available treatise in English on the morphology of the beetles belonging to the family Scarabæidæ. The nearest approach to the subject is the famous historical French work of Straus-Durckheim "Considérations Générales sur L'Anatomie Comparée des Animaux Articulés" in which is included a description and many fine drawings of the anatomy of *Melolontha vulgaris*, Hanneton. This work appeared in 1828 and is a masterpiece of its kind. However, much of the anatomical nomenclature is now antiquated and the work itself hard to secure, consequently the present paper, dealing with a species of a closely allied genus of the same family, is here presented.

The nomenclature used by the writer is that which was deemed most useful. It follows no one system of the modern writers but is adopted from such writers as Snodgrass, Crampton, and others.

This species of the genus *Lachnosterna* was chosen for study because of its abundance in the vicinity of Manhattan, Kansas. Of the 23 species found in this vicinity, *L. crassissima* ranks first in relative numbers. A total of 86945 specimens of this genus have been collected by Mr. J. W.

¹ Contribution No. 54 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies the results of some of the investigations undertaken by the writer in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station. The writer wishes to acknowledge his indebtedness to Dr. P. S. Welch for many helpful criticisms during the course of preparation of this paper and to the American Microscopical Society for a grant from the Spencer-Tolles Fund to publish the accompanying drawings.

McColloch and the writer during the years 1916-1920, and of this number 30230 were *L. crassissima*. The specimens were preserved in 70% alcohol, boiled in potassium hydroxide when ready to use, and studied under the binocular.

GENERAL CONSIDERATIONS

Size.—The adults of this species are among the most broadly ovate of the genus *Lachnosterna*. They vary greatly in length, width, and maximum depth, and, on an average, the females are somewhat longer than the males, as well as much broader posteriorly. The greatest body depth varies in individuals of both sexes. Not only in size is this difference noticeable, but also in respect to the regions of the body in the two sexes. The males have their region of greatest depth through the thorax, which was found to average 7.1 mm., while the females are deepest through the posterior end of the abdomen where they average 7.6 mm. Some of the depth variation in the females is due, in part to the degree of flexibility of the intersegmental grooves, especially when the abdomen is distended with eggs.

Because of the deflexity of both the labrum and pygidium, the maximum length of the males and females was arbitrarily measured from the emargination of the clypeus to the basal or proximal edge of the pygidium and not to the extreme ends as is the usual practice. The average length of 25 males, chosen at random, was 18.2 mm. and, for the same number of females, 18.7 mm. The maximum length of the males was 20 mm. and of the females 20.9 mm., while the minimum was 16.3 mm. for the males and 16.5 mm. for the females. Width measurements were made at seven different regions of the body to get a general notion of the width variation. These regions were chosen arbitrarily as follows:

- 1—At anterior margin of the eyes
- 2—At anterior margin of prothorax
- 3—At lateral angles of prothorax
- 4—At base of prothorax
- 5—At base of elytra
- 6—At bulge near middle of elytra (widest points)
- 7—At declivity of elytra near the distal end.

The table on the opposite page shows the average width, length, and depth measurements of 25 males and 25 females.

In individual specimens, the length measurement is highly variable, depending on the character of the specimens at hand. Alcoholic and living specimens are extensile because of the telescopic nature of the union of head and thorax and to a lesser degree the thorax and abdomen, thus causing differences in length. Dried specimens will, on the contrary, permit of more constant measurements.

Color.—The general mass color of this species is chestnut-brown or castaneous (dragon's blood plus a slight admixture of vermilion—Smith's

color chart, 1906, p. 154). However, some specimens vary to a dark brown, almost black, in which case a grayish iridescence is very apparent. Dorsally, the head, thorax, and elytra are shining and in certain lights a gray color exists. This grayish tinge is a structural color caused by fine striæ on the elytra. These striæ are also present on the thorax but the iridescence is not so pronounced. The eyes are black and prominent. Ventrally the ground color is castaneous. The thorax is covered with dull, yellow hairs, 1.5–2 mm. long, somewhat sparsely scattered on the prothorax, but several times denser on the meso- and metathorax. The abdomen frequently has a grayish super-color imparted by an adhering exudation which can be scraped off. The legs and antennæ are lighter brown, almost ferruginous in color.

TABLE I.—AVERAGE SIZE OF VARIOUS BODY REGIONS

Sex	Average Length	Width							Greatest Depth
		Head	Prothorax			Abdomen			
		At Eyes	At Anterior Margin	At Lateral Angle	At Base	At Base	At Bulge	At Declivity	
Males. . .	mm. 18.2	mm. 4.7	mm. 5.2	mm. 7.2	mm. 7.8	mm. 8.4	mm. 9.8	mm. 7.6	mm. 7.1
Females.	18.7	4.3	5.1	7.8	8.1	8.6	10.3	8.2	At thorax 8.2 At abdomen

SEXUAL DIMORPHISM

Male.—The club of the antennæ (Plate I, fig. 4) is about equal in length to the scape (s.) and funicle (fu.) combined. At the middle of the ventral surface the abdomen is longitudinally depressed and the penultimate ventral segment bears a faint transverse carina near its distal end. Frequently, this carina is nothing more than a slightly wrinkled convexity. Immediately behind this carina the last, or ultimate, ventral segment has a deep, rounded fovea whose distal margin is obtusely and angulately emarginate. On the posterior tibia, the inner spur is about one-half the length of the outer and somewhat more slender spur. The pygidium is not gibbous and is more noticeably truncate at the distal end than is this structure in the female. The hind tarsi are longer than those of the female.

Female.—The club of the antennæ (Plate I, Fig. 5) is about as long as the funicle. The ultimate ventral abdominal segment is somewhat broadly and rather deeply emarginate distally, and the fovea is absent. The pygidium is gibbous, smooth, and shining at the apex of the gibbosity and more

exposed than in the male. Ventrally, the abdomen is more broadly rounded and shining than that of the male and the longitudinal depression is lacking. The inner spur of the hind tibia is about equal in length to the outer and about as wide as the same spur in the males, while the hind tarsi are shorter than in the male. The tooth of the tarsal claws is somewhat larger than this tooth in the male.

CONTRAST OF BODY SURFACES

Dorsal Surface.—The dorsum of the head, thorax, and abdomen, by a casual examination, appears smooth and shining, but closer scrutiny reveals minute punctures over the entire surface. These punctures are more numerous on the front than on any other part of the body. Here they are closely placed, and often confluent. The clypeus is less densely punctured and the punctures are about equal in density to those on the thorax. A setigerous canthus is found on the eye. On the thorax a faint, smooth, median, longitudinal line is formed by the absence of punctures. Laterally, the punctures are less dense. The lateral margin is serrate and hirsute, and at the base transverse channels extend mesad, failing to reach the median line. The scutellum is large, somewhat heart-shaped, irregularly and less densely punctured. The elytra are likewise irregularly punctured, and five indistinct costæ occur on each elytron.

Ventral Surface.—Ventrally, the head is dark-brown, sparsely hairy and, in part, concealed under the anterior ventral margin of the thorax. The thorax is thickly covered with pale, yellow hairs about 1.5 mm. long, and the legs are sparsely covered with shorter hairs. The punctures of the ventral abdominal surface are, on the whole, smaller than the dorsal ones. Each bears a short, recumbent hair and is more widely separated. There are about the same number of punctures per square millimeter as on the upper surface where they are larger but more closely placed.

CONTOUR

The transverse contour of the body exhibits four distinct geometrical figures in three principal regions of the body. Through the head a narrow, elongated oval is apparent, through the thorax a broad oval, while the abdomen shows a somewhat different contour for each sex. In the female, it is broadly oval, almost circular, and in the male much the same, except for the ventral surface where the oval is somewhat flattened, due to the fovea on the lower surface of the abdomen.

BODY DIVISIONS

The three general regions of the body are to be recognized by definite sutures which separate them. The head is the smallest division, being less than one-half the width of the thorax. It is greatly depressed and deflected. From above only the clypeus, front and eyes can be seen, as

the labrum is deflected on the under side of the head. The head is telescoped within the thorax and connected to it by a sclerite-bearing cervicum or the so-called microthorax.

The thorax is next in size to the head, somewhat oblong, being nearly twice as wide as long. The sides are nearly parallel at the base, but converge anteriorly. The oval contour of the three segments of the thorax is nearly similar in each with perhaps a more flattened aspect of the prothorax. Dorsally, the meso- and metathorax each bear a single pair of wings, those of the mesothorax being modified to form the elytra which cover the metathoracic wings. Each segment of the thorax bears a pair of jointed legs.

The abdomen, which is larger than the other two divisions combined, is completely covered by the elytra, except at the pygidium. The pygidium is more exposed from above in the female than in the male. On the lower surface are found only six abdominal segments, while eight are apparent on the upper surface after removing the elytra. This condition is apparently constant in both sexes. The sexual differences of the abdomen have already been described. The abdomen is telescoped into the thorax on the lower side, and united to the metacoxæ. Dorsally, the connection is made by a membrane to the postscutellum, and the parts do not overlap. The intersegmental grooves on the dorsum are comparatively wide and the fusion of the segments is loose and flexible, while ventrally, the segments are closely fused, forming narrow, curved grooves. Seven pairs of spiracles are to be found on the abdomen, only one of which can be seen below the elytra. The others are mostly in the ridges formed in the pleura.

THE STRUCTURE OF THE HEAD

Front and Vertex.—The size and general contour of the head (Plate I, figs. 1–2–3) have already been noted. It is partly withdrawn into the prothorax and the mouth parts are wholly on the inferior surface with but a small part of the labrum visible from above. The front (Plate I, fig. 1, fr.) is a large somewhat rectangular area lying between the eyes, and limited anteriorly by the suture separating it from the clypeus (cly.). Its outer angles are extended to form the canthus of the eye (cn.). No epicranial suture is present and the region is not sharply separated from the vertex. The front is closely and strongly punctate. Near the vertex, at the point where the prothorax overlaps the head, the punctures disappear rather abruptly, except near the eyes, leaving a strong line of demarkation between the punctured area and the smoother region of the vertex and occiput. A few scattered punctures are to be found in these regions. Each puncture bears a recumbent hair which is inclined anteriorly. The vertex (v.) merely consists of the upper region of the head having no definite

boundaries but lying between the front and the occiput; the occiput being the posterior region of the head lying above the opening of the occipital foramen. No ocelli are present.

The Clypeus and Canthus.—The clypeus (Plate I, fig. 1, cly.) is situated on the anterior margin of the front, and the suture separating them, which is strongly sinuate, is known as the clypeo-frontal suture. The clypeus is somewhat rectangular, being twice as wide as long. Numerous punctures are present but they are not as dense as on the front. The anterior margin is slightly emarginate and a strong upturning gives to the whole sclerite a deeply concave appearance. The postero-lateral corners of the sclerite are bordered by the eyes and at this point a chitinous process protrudes upon and partly divides the eyes. This process, known as the canthus (Plate I, figs. 1 and 2, cn.), appears somewhat as an extension of the clypeus, but in reality is a continuation of the anterior corners of the front lying partly under the clypeus. Hairs are scattered over the surface of the canthus.

The Labrum and Epipharynx.—The labrum (Plates I and II, fig. 1, labr.) is attached to the anterior border of the clypeus, being greatly deflected and nearly hidden by the clypeus. Dorsally it is somewhat semi-circular in outline and is depressed to form a deep fovea near the center. It is covered with long thinly placed hairs. On its inner surface are two convergent rows of mesadging point hairs (Plate II, fig. 1).

The epipharynx (Plate II, fig. 1, epi.) is greatly reduced in this species. It has almost disappeared because of the extension of the labrum over most of its entire surface. A somewhat triangular elevated clump of hairs, or spines, is the most conspicuous remnant of the epipharynx.

The Eyes.—The eyes (Plate I, figs. 1–2–3, e.) are the most prominent part of the head. They are large, somewhat oval bodies on the dorsal, lateral and ventral regions of the head. They are nearly divided dorsally by the canthus.

The facets (Plate I, fig. 6, fac.) which are about .021 mm. in diameter, average about 380 to the square millimeter. In shape they are somewhat regularly hexagonal and each hexagon is the cornea of a completely distinct eye.

Genæ and Gula.—The lateral parts of the epicranium form the genæ (Plate I, figs. 2 and 3, g.) whose ventral limits are determined by the sutures separating the genæ from the large head sclerite—the gula (Plate I, figs. 2 and 3, gu.). The gula occupies about one-third of the ventral surface of the head. It is somewhat quadrate in outline, being slightly wider anteriorly where it is separated from the submentum by a transverse suture. The lateral margins are limited by the gular sutures and posteriorly by the cervical membrane.

The Occipital Foramen and Tentorium.—The occipital foramen, or foramen magnum, is the large opening in the head, opposed to a like opening in the thorax.

Through the occipital foramen can be seen, within the head, a chitinous structure, the tentorium (Plate V, figs. 1–2–3, tent.). A large arch-like structure represents the body of the tentorium, while a pair of small, short, posterior arms (post. a.) are present. The anterior arms (ant. a.) are broad structures extending cephalad from the body of the tentorium, and the dorsal arms (dor. a.) are represented by a pair of short pointed processes extending cephalad into the head cavity.

The Cervicum and its Sclerites.—The membranous area between the head and thorax is known as the cervicum. It contains six cervical sclerites. No attempt to homologize these sclerites has been made. The drawing (Plate V, fig. 4) shows the left side of the cervicum with the dorsal edge to the right and the anterior edge toward the top. It will be seen that near the dorso lateral margin is a small hair-bearing sclerite and near the ventro lateral margin are two sclerites, a large anterior one which overlaps a small posterior one.

THE HEAD APPENDAGES

The Antennæ.—The antennæ (Plate I, figs. 4 and 5) have been previously mentioned under the discussion of sexual differences. The male (Plate I, fig. 4) has a much larger club than the female (Plate I, fig. 5). Normally both sexes have 10 segments, three of which go to make up the lamellate club (cl.). The others form the funicle (fu.) and scape (sc.).

The Mandibles.—The mandibles (Plate III, figs. 1 and 6) are large complicated structures bearing on their inner surface a large, oval, grinding, or molar surface (mo.). Extending over the molar surface are a number of transverse ridges which are used in the process of grinding food. The anterior end of the mandible is thought to be the homologue of the galea of the maxilla. It is modified into a sharp cutting edge with two blunt teeth (gal.). Near the anterior end of the molar surface is a membrane (memb.) bearing various shaped spines and setæ which are shown in Plate III, figure 5. Immediately caudad of the molar surface is still another membrane (memb.) bearing short broad stiff spines. These are shown enlarged in Plate III, figure 3. A transverse section through the molar at the junction of the ridges (Plate III, fig. 4) shows a flat surface with small ridges extended ectad over half the surface.

Two chitinous apodemes (Plate III, fig. 2) are attached to muscles controlling the movement of the mandible.

The Maxillæ.—Each maxilla (Plate II, fig. 3) is divided into five principal regions: the cardo, stipes, palpifer, galea and lacinia. There seem to be no sutures delimiting a subgalea or dividing the galea into two lobes. The cardo (cd.) is rather short and broadly club shaped, being constricted

somewhat posteriorly. Across the center is an abrupt change in contour, making the anterior region of the cardo much thicker dorso ventrally. This change of level is represented in the drawing by the transverse dotted line. The stipes (st.) is the large median triangular sclerite, alongside of which is the long narrow palpifer (max. pf.) bearing a four-jointed palpus (p.). On the margin of the stipes opposite the palpifer is a large somewhat triangular area with one corner elongated to form a large spine-bearing lobe. This is the lacinia (lac.). On the ectal margin of the lacinia is a large five-toothed heavily chitinized structure, the galea (gal.).

The Labium and Hypopharynx.—The labium (Plate II, fig. 2) is separated from the gula by a transverse suture which extends across the ventral surface of the head in the region where the cardo of the mandible is articulated. Following Kadic's (1902, pp. 207–228) interpretation of the labium of Coleoptera, we find the following regions:

The submentum is divided transversely into two regions, the anterior plate (Ap. Sm.) and the posterior plate (pp. sm.). The posterior plate is attached to the gula and is much wider at the postero lateral margins, somewhat constricted at the middle and slightly broader anteriorly. The anterior plate is more nearly quadrate, broader than long, and with the lateral edges rounding out to form a bulge near the middle of the sclerite. The mentum is separated from the anterior plate of the submentum by a transverse suture which has a distinct emargination near its center. Similarly, it is somewhat broadly quadrate and bears a few mesad pointing hairs. The anterior margin is strongly biemarginate.

The glossa and paraglossæ (Plate IV, fig. 1) are not evident on the ventral surface but are bent within the buccal cavity. The glossa (gl.) is a single median sclerite, while the paraglossæ (plg.) are found on either side of it. They bear the three-jointed labial palpi. These structures are not easily located without having well cleared specimens. Near the base of the palpus on the inner surface is a diagonal suture limiting an area termed the squama palpigera (sq. pl.).

The hypopharynx (Plate IV, fig. 1–3 hyp.) is a V-shaped spiny structure lying on a clump of spines or strong hairs, principally on the inner surface of the anterior plate of the submentum. Caudad and dorsad to the hypopharynx are two long, narrow, chitinous structures known as the fulcrum hypopharyngeum (ful. hyp.). At the dorso-posterior end are two small transverse sclerites constricted somewhat near their middle. These are the pharyngeal sclerites (phy. scl.). To these structures are attached the anterior margins of the pharynx (phar.) and just posterior to the hypopharyngeum, on each side, is a row of backward pointing hairs. Anteriorly, the two arms of the fulcrum hypopharyngeum unite under the pharynx to form a sort of strengthening apparatus for the spiny structure underlying the hypopharynx which extends forward to form three arms.

These are shown on their ventral aspect in Plate IV, figure 2. A lateral view showing the relation of these parts to the pharynx (phar.) is shown in Plate III, figure 3.

THE PROTHORAX

Protergum.—(Plate VI, fig. 1). The tergum of the prothorax or pronotum is convex, nearly twice as broad as long, with the sides somewhat narrowing from the base to the apical margin and constricting rather suddenly anteriorly. The lateral margins are distinctly crenate and ciliate, but not so represented in the drawing. A deep emargination occurs on the anterior margin which overlaps the head, extending to the middle of the eyes. The posterior margin is broadly angulate and overlaps, as far as the elytra, the mesothorax to which it is connected by a membrane. Close, though not very dense, punctures cover the surface, and a smooth median caudo-cephalad line is faintly evident. On each side near the posterior margin is an incipient channel extending from the postero-lateral angle to within a short distance of the middle.

Pleura.—At the lateral margins, the tergum is not inflexed to form the so-called prothoracic epipleuræ which are strongly evident in some Coleoptera (e.g. *Pterostichus californicus* Dej.). The prosternum (Plate VI, fig. 2, pro. ster.) and the pleural sclerites compose the ventral aspect of the prothorax. The episternum (Plate VI, fig. 2, eps.) and the epimeron (epm.) have no line of separation. Anteriorly, the episternum elongates mesally to fuse with the sternum whose anterior margin turns inwardly to form a phragma. Likewise, the epimeron extends mesally, tapering towards its extremity. Thus the two extensions form the anterior and posterior margins of the coxal cavities (cc.). The junction of the epimeron with the posterior region of the sternum creates in other Coleoptera the closed coxal cavities. These are partly open. This species has no suture, as in *Melolontha vulgaris*, separating the sternum from the episternum.

Prosternum.—The prothoracic sternum (Plate VI, fig. 2, pro. ster.) occupies the inferior, median region of the prothorax. It is quite irregular in shape and has, as mentioned before, no distinct line of demarkation separating it from the episternum. Externally, a noticeable feature is a caudad-projecting tongue between the cavities of the coxæ. At the anterior end of this tongue an irregular, circular ridge causes the formation of a somewhat rounded depression of the sternum. This tongue-like projection after attaining the posterior margins of the coxæ is expanded at right angles and extends laterally to meet the epimeron of each side. Internally, after the removal of the coxæ, the sternum will be found to have enlarged into a somewhat rectangular piece with rounded postero-lateral corners. It tends to form a concavity in which a part of each coxa rests. On the sides of the anterior edge of the internal sternum are two prolonged

entosternal apophyses (Plate VI, fig. 3, es. aph.) which extend dorso-laterally.

The first pair of spiracles located ventrally are suspended in the membrane which unites the prothorax to the mesothorax.

THE PROTHORACIC LEGS

The Trochantin.—(Plate VI, fig. 6, tn.). The trochantin is a small piece hidden within the interior of the prothorax, which, when viewed from its caudal aspect, presents a depressed or cup-like structure articulating with the anterior margin of the coxa. The latero-dorsal margin bears a small, somewhat sharpened corner that is loosely articulated with a small apodeme on the inner surface of the prothoracic episternum. The end of the coxa articulates with the lower end of this same apodeme.

The coxa.—(Plate VI, fig. 6, cx.). The coxa of the anterior leg is cylindrical in form, and slightly over three times as long as its greatest diameter. It lies transversely in the coxal cavity of the prosternum and extends laterally under the edges of the pleura, thereby concealing the articulation with the trochantin. On the inner surface is a large opening extending from near its lateral extremity to nearly half its length. The cephalic edge of this opening articulates with the trochantin and the caudal edge is connected by a membrane to the arms of the epimeron lying immediately behind. The opening is partly closed by an overlapping of its edges which serve as places of attachment for several muscles.

At the distal end the coxa likewise articulates with the sternum near the mid-ventral line, and is thus fixed at both ends so that it moves in a rotary manner on its axis. There is a second opening at the distal end which receives a prolongation of the trochanter and thus permits of articulation at this point.

The Trochanter.—(Plate VI, fig. 6, tr.). The trochanter is a small triangular piece lying between the coxa and femur, articulating with both the coxa and femur, being more firmly attached to the latter.

The Femur.—(Plate VI, fig. 6, f.). The femur is about as long as the coxa, is somewhat flattened and bears on its inner surface a groove-like depression in which the tibia may rest when folded back on the femur. A socket is located in its distal end which receives a condyle from the tibia, forming a ball and socket articulation between the femur and tibia.

The Tibia.—(Plate VI, fig. 6, t.). The tibia is remarkably adapted for burrowing in the soil. It is somewhat obliquely truncate at its apex, about equal in length to the femur, and is strongly compressed, especially at its anterior edge which bears the three tibial teeth. Of these the terminal tooth is very strong and about as long as the first tarsal joint, while the other two are broader and not so long. Near the femur the tibia is rather cylindrical and bears a terminal condyle for articulation with the

femur. On its external margin, opposite the three teeth, is a strong movable spine.

The Tarsus.—(Plate VI, fig. 6, tar.). The tarsus is composed of five segments. The first four are about of equal length, the fifth slightly longer. They are cylindrical, and become enlarged distally. The terminal segment bears a pair of large claws (t. cl.) each of which bears an intra-median (male) or median (female) tooth. The tooth is slightly larger in the female.

THE MESOTHORAX

The Mesotergum.—(Plate VII, figs. 1, 2, 3). The mesothorax is the smallest of the three divisions of the thorax; it bears the second pair of legs and the first pair of wings modified to form the elytra (Plate VI, fig. 4). The dorsal or tergal region of the mesothoracic segment is occupied largely by the somewhat triangularly shaped scutellum adjoined to which are the points of attachment of the elytra (Plate VI, fig. 5). Three regions of the four which comprise the typical thoracic tergum (Snodgrass, 1909, p. 523) are to be distinguished in this species, namely, the praescutum, scutum and scutellum. The postscutellum, or pseudonotum of some writers is absent.

The Præscutum (Plate VII, figs. 1 and 2, praes. ph.) is composed of a small meso-cephalad projecting phragma between the prothorax and the metathorax. It is slightly concave and is reinforced at its cephalic margin by a somewhat heavier deposition of chitin, which forms a rod-like brace extending from one edge of the præscutum to the other (Plate VII, fig. 3). The scutellum (Plate VII, figs. 1, 2, 3, scl.) is a large somewhat triangularly shaped sclerite part of which is covered by the elytra leaving the posterior half exposed externally. Its anterior or covered portion is somewhat closely punctate and covered with recumbent hairs while the exposed part is sparsely punctate, devoid of hairs and rather shining. The lateral margins each bear, on their anterior halves, two mesad-projecting pieces which represent the divided regions of the scutum (Plate VII, fig. 2, scl.). These phragma-like pieces are nearly triangular in shape and each terminates in a pointed ventro-cephalad projecting process which rests on the underlying metathoracic præscutal phragma (Plate VII, fig. 2, prs. ph.), and articulates with its antero-lateral projecting corners. At the cephalic margin of the scutum is a small depression or cavity in which the third axillary of the elytra lies when in the state of rest. The caudal margins are extended backward and unite to form a semicircular reduplication on the inferior surface of the exposed portion of the scutellum (Plate VII, fig. 3, scl. red.). To this reduplication is attached a small membrane which connects the mesothoracic tergum to the lateral and caudal margins of the metathoracic præscutal phragma. The cephalic margin of the scutellum bears a membrane which connects the prothorax and mesothorax. The

cephalo-lateral angles of the scutellum articulate with a small, sharp process which projects ventrad and unites with the anterior margin of the mesoepisternum.

The Elytra.—(Plate VI, figs. 4 and 5). The elytra which cover the meso- and metathorax and the greater portion of the abdomen are large, somewhat rectangular wing covers extending caudad to the middle of the penultimate abdominal segment, leaving the pygidium exposed. Their lateral and posterior margins are somewhat abruptly declivitous. The upper surface bears faint traces of the nervures and at each humeral angle there is a slight protuberance. The elytra are inserted on the mesothorax between the scutellum and the mesopleura. The base of the wing covers is somewhat truncated and curves ventrad. Near the middle of the basal margins on each elytra is a strong, bifurcated apophysis (Plate VI, fig. 5), which articulates with the wing process of the mesothorax, there are three principal wing axillaries (Plate VI, fig. 5, 1 ax., 2 ax., 3 ax.) in the membrane which are very irregular in shape and impart a different appearance from every aspect in which they are viewed.

The interlocking mechanism of the elytra is similar to that described for *Lachnosterna fusca* by Breed and Ball (1908, p. 291) who found in Coleoptera four devices for fastening the elytra in place. These are described by these writers as follows:

1. By a co-adaptation of the elytra along the dorsal suture.
2. By means of a groove on the dorsal face of the metathorax into which the swollen inner edges of the elytra fit.
3. By slipping the anterior edges of the elytra under the scutellum and hooking them (a) on to the scutellum, or (b) on to the metathorax. Pressure derived from the retracted prothorax may aid in keeping these edges in position.
4. By hooking the anterior lateral edges of the elytra over ridges or into grooves on the lateral faces of the metathorax.

In *Lachnosterna*, the first three methods are used to interlock the elytra while the fourth is present but not functional.

The Mesopleura.—(Plate VII, figs. 4 and 5). The mesopleuron consists externally of two sclerites, the episternum (eps.) and the epimeron (epm.). The episternum is a subrectangular plate with a strongly rounded dorsal margin, which adjoins the alar membranes. The anterior and posterior margins are nearly parallel, the former serving as a place of attachment for the intersegmental membrane, and the latter bordering on the epimeron. The ventral margin is attached to the mesosternum (ms. ster.). The epimeron (epm.) is nearly trapezoidal in shape with the cephalic and caudal margins nearly parallel. The cephalic margin connects with the episternum, the caudal one joins the metathorax, the dorsal margin gives attachment to the alar membrane and the ventral margin tapers to meet and

connect with the coxa of the mesothoracic leg (cx.). Between the coxa and the episternum is a small, narrow sclerite not visible externally—the trochantin (Plate VII, fig. 4, tn.) which articulates by means of a small condyle with the coxa. This sclerite is not present in the corresponding region of the metathorax.

An internal view of either of the mesopleura (Plate VII, fig. 5) shows a strong entopleural structure arising along the suture separating the episternum and epimeron and forming a pleural ridge which tapers at its ventro-mesal angle into a pleural arm (pl. a.) extending into the body cavity and terminating in a cup-shaped disk which serves for the attachment of muscles. The caudal margin of the epimeron presents internally a strong reduplication which aids in concealing the spiracles of the second pair of respiratory organs. The spiracles are not visible externally but lie in the suture between the mesoepimeron and the metaepisternum. The dorsal margin of the episternum is modified into a strongly chitinated blunt process, constituting the wing process on which articulates the bifurcated apophysis of the elytron.

The Mesosternum —(Plate VII, figs. 6 and 7, ms. ster.). The mesosternum is a transverse quadrilateral plate whose anterior margin serves as a place of attachment for the intersegmental membrane lying between the pro- and mesothorax. Its lateral edges border on the ventral margin of the mesoepisternum, and the posterior margin presents a biemarginate appearance with a median, caudal projecting piece which extends between the coxæ. The whole external posterior margin is bordered by the meso-coxal cavities. With the coxa removed, it can be observed that the posterior margin is extended into a concave process in each cavity in which the coxa lies at rest. The extension joins the metasternum caudad of the coxæ.

The internal surface of the mesosternum (Plate VII, fig. 7, ms. ster.) shows a furcate process arising from the anterior portion of the concavities occurring in the coxal cavities. It consists of two antero-dorsal pointing arms forming the so-called entosternum, or mesoentosternum, of the mesothorax. These arms are supported near their middle by a chitinous of the cephalic margin of the mesosternum.

THE METATHORAX

Metatergum —(Plate VIII, figs. 1 and 2). The four typical tergal regions are present in the metathorax. The præscutum (prs. ph.) is represented by three distinct pieces, a large semi-oval median prephragma or præscutal phragma separated from the scutum by a large membranous area and two lateral parts (praes.) which support the large præscutal phragma. The scutum (sct.) is composed of two large lateral halves separated by the notal groove (n. g.) containing the scutellum. The scutal halves are divided diagonally into an anterior and posterior region. The

anterior region bears laterally the anterior notal wing process (a. n. p.) and the posterior region (the so-called "*scapulaire posterieure*" of Straus Durckheim) carries laterally the posterior notal wing process (p. n. p.) and the axillary cords (ax. c.). The diagonal line of demarkation causing the division of the scutal halves is the outer evidence of an internal ridge (Plate VIII, fig. 2, d. rd.) on the interior surface of the scutum. The metascutellum (Plate VIII, fig. 1, scl.) is a two-lobed piece at the posterior median angles of the scutum. It elongates cephalad to form a tongue-like process, which lies in the notal groove and is limited anteriorly and dorsally by the membrane separating it from the præscutal phragma and internally by the entodorsum or V-shaped ridge (ent. d.) on the internal aspect of the metatergum. The postscutellum (pss.) is a large, irregular piece lying immediately behind the scutellum and scutum. It bears the post-phragma (post. ph.), is inflexed mesad to furnish attachment for several muscles and also bears the membrane which connects the thorax with the abdomen. The lateral edges are inflexed caudad of the alar membranes and articulate with the epimera of the metathorax.

The Wings.—(Plate VII, fig. 9). The second or metathoracic pair of wings, which are membranous, are borne on the metathorax and are inserted between the metatergum and the metapleura in the alar membranes. In a state of rest the wings are transversely folded under the elytra and in flight extend nearly at right angles to the body. The wings are articulated to the body by four axillary sclerites (Plate VII, fig. 10, 1 ax., 2 ax., 3 ax., 4 ax.) similar to those described in *Melolontha* (Straus Durckheim p. 109), one of which (4ax) according to Snodgrass (1909, p. 545) is an accessory plate not corresponding to the fourth axillary in other forms. The first axillary lies laterad of the scutum and its anterior outer margin abuts the basal enlargement of the subcostal vein of the wing. Between the first axillary and the bases of the radius and medius lies the second axillary which is partly overlapped by the first. The third is larger than the second, and lies at the bases of the cubital and anal veins, while the fourth axillary is quite small and lies between the first and third axillaries.

The Metapleura.—(Plate VIII, figs. 3 and 4). The metapleuron is composed of two principal sclerites homologous to those of the mesopleuron—the metaepisternum and metaepimeron—each of which is subdivided into two regions. The lower division of the episternum or katepisternum (keps.) is an irregular semioval piece attached to the lateral margin of the metasternum. Its dorsal and posterior margins are connected to the lower edge of the epimeron. Dorso-anteriorly the episternum exhibits the second subdivision or anepisternum (aeps.). This is an irregular shaped piece bordering on the cephalic edge of the epimeron and to which is fused the lower part of the preparapтерum (pptm.) which is likewise fused with

the base of the wing process (w. p.). Internally the preparapterum bears a large muscle disc or pronator disc (pn. d.).

The epimeron is divided into two parts, the katepimeron and the anepimeron. The latter (aepm.) lies immediately above the katepisternum and is elongated anteriorly to form the wing process (w. p.). The katepimeron (kepm.) is a quadrilateral piece lying caudad of the anepimeron. Just above the epimeron is the alar membrane in which is located the wing axillaries. The epimeron is connected posteriorly by an articulation with the postscutellum on its lateral edge. On its inner surface the suture between the episternum and epimeron is extended to form the pleural ridge which elongates into an adfurcal process (pl. a.) that rests on the lateral arm of the mesoentosternal furca. The ventral end of the pleural ridge extends to the coxa.

The Metasternum.—(Plate VII, figs. 6 and 7). The metasternum occupies the lower surface of the metathorax. It is much the same in shape as that of the mesothorax, but considerably larger and lies between the meso- and metacoxæ. On the internal surface of the sternum (Plate VII, fig. 7) is the large endosternum projecting dorsally (Plate VII, fig. 8). It consists of two laterally projecting arms which furnish support for the adfurcal processes of the entopleura and a large and somewhat pointed cephalad projecting arm. A manifestation of this structure is discernible on the outer surface of the metasternum in the form of a faint mid-ventral line.

THE METATHORACIC LEGS

The metathoracic legs are different in structure, especially in the form of the tibiæ from the prothoracic legs which, as mentioned before, are remarkably adapted for burrowing. While this modification is not present in the hind tibiæ, broadly speaking the metathoracic legs are quite similar to those of the mesothorax which for this reason are not treated in this discussion. In the metathoracic legs a well marked sexual difference, to which reference has been made, is apparent in the distinctly longer tarsi of the male. The trochantin of the metathoracic legs is absent, although it is to be found both in the pro- and mesothoracic pairs.

The Coxa.—(Plate VIII, fig. 5, cx.). The coxa of the metathoracic leg is attached to the posterior margin of the ventral surface of the metathoracic segment, and likewise serves as a place of attachment for the intersegmental membrane lying between the thorax and abdomen. Externally it presents a flattened surface in the same plane as the metasternum and like the coxa of the prothoracic legs is more or less immobile, except in a semi-rotary manner. It lies at right angles to the longitudinal axis of the body and extends from the elytra at the lateral margin to the mid-ventral line. Internally it presents a hollow arrangement near the opening

of which is a chitinous ridge or infolding that permits the attachment of the flexor muscles.

The Trochanter.—(Plate VIII, fig. 5, tr.). The trochanter of the metathoracic leg is similar to that of the two other pairs of legs. It lies between the coxa and femur and is triangular in shape.

The Femur.—(Plate VIII, fig. 5, f.). The femur is slightly longer than the coxa. It is somewhat flattened with rounded edges, tapering toward the distal end where it articulates with the tibia.

The Tibia.—(Plate VIII, fig. 5, t.). The tibia of each meso- and metathoracic leg differs from that of the prothoracic leg in that there is no flattened modification for digging and burrowing as is present in the front leg. The proximal end articulates with the femur and the distal end with the tarsus, where it is slightly broadened and bears two sharp spurs varying in size in the two sexes. These have been described in the paragraph on Sexual Dimorphism.

The Tarsus.—(Plate VIII, fig. 5, tar.). The tarsus is similar to that of the other legs in having five segments. The terminal one has two sharp claws, each bearing a median tooth.

THE ABDOMEN

The abdomen of *Lachnosterna* almost equals in volume the remaining portions of the body, and is directed in the horizontal plane. At its base it equals the thorax in size, to which it is attached throughout its complete circumference. Dorsally, it is connected by a membrane to the postscutellum and thereby conceals the postphragma. Ventrally, it is joined to the posterior edge of the internal opening in the metathoracic coxæ.

Concerning the number of evident (not actual) abdominal segments in this species, there are six ventrally and eight dorsally, while the actual number is perhaps eight ventrally and nine dorsally (Plate VIII, fig. 8). The ninth or terminal segment is reduced in size with only the ventral portion apparent externally, while the dorsal part is modified to form an infolding within the anal opening and is not visible from the exterior. Each segment, with the exception of the first, consists of two principal parts, a dorsal or tergal region, and a ventral or sternal area. The dorsal and ventral sclerites are united laterally by a membrane which permits dilation and contraction of the abdomen. Posteriorly, the membrane disappears, leaving no such separation between the terga and sterna of the terminal segments.

The Terga.—Nine terga are present. The elytra in the state of rest cover the first six terga which are only slightly chitinized. There is evidently not the necessity of heavier chitinization which characterizes the remaining or unprotected parts of the body. These terga are united by comparatively wide membranous areas which are larger laterally than

near the median region. The two remaining visible terga (seventh and eighth) are not protected by the elytra and are consequently densely chitinized as is also the ninth which has disappeared within the anal opening. The seventh and eighth are the widest tergites. They make up the pygidium and are more closely fused than the anterior terga.

The Sterna.—The first sternite has disappeared and only a rudiment of the second is present which is covered by the metathoracic coxæ. The remaining segments are more heavily chitinized than the second, are closely fused to each other, and permit of no movement as in the terga. The male sternites (Plate VIII, fig. 6) are somewhat flattened and the eighth sternite has a rounded fovea which is absent in the female (Plate VIII, fig. 7). These differences, due to sex, have been mentioned in the discussion of sexual dimorphism.

The Spiracles.—There are nine pairs of spiracles, two thoracic and seven abdominal. The first pair of prothoracic spiracles is located ventrally, and each spiracle is suspended in the membrane which unites the prothorax to the mesothorax. The second pair is not visible externally but is to be found in the suture between the mesoepimeron and the metaepisternum. The third pair, or first abdominal pair, lies dorsally in the membrane between the metathorax and the first abdominal segment. The next five pairs are found on the ridge formed between the tergites and sternites. These six pairs of abdominal spiracles are covered by the elytra. The last, or posterior pair, is exposed below the elytra on the seventh abdominal segment and lies in the suture between the sternum and tergum.

The Genitalia.—The genitalia properly speaking are perhaps more concerned with internal anatomy and should be discussed in such a treatise. However, they possess chitinous structures which are tegumentary in nature and will, therefore, be briefly discussed here, chiefly because of their importance as specific characters in taxonomy.

In the male (Plate IX, figs. 2 and 4) a heavily chitinized semicylindrical sheath or box, termed the telum (Plate IX, fig. 4, te.), surrounds the true membranous penis. The posterior end is shown in perspective in the drawings showing its relation to the claspers which surmount the telum and in this species are rather symmetrical. These claspers (Plate IX, fig. 2, cls.) are of much taxonomic importance.

Underlying the telum is a small Y-shaped chitinous structure (Plate IX, fig. 3). Posteriorly, the branching arms are bent dorsally and to them is attached the membrane which constitutes the anterior region of the cloaca. The membrane is also attached to the inner margin of the last ventral and abdominal segments. Anteriorly, this structure extends into the body as far as the sixth ventral abdominal segment.

The female genitalia (Plate IX, fig. 1) are shown in three views. The organ consists of a pair of broad inferior plates (inf. pl.) which surround a

smaller pair of superior plates (sup. pl.) somewhat cylindrical in shape and strongly divergent.

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LIST OF ABBREVIATIONS

a.	anal opening	a.n.p.	anterior notal wing process
a.a.	anterior arm of endosternum	ap.sm.	anterior plate of submentum
1 _a 2 _a 3 _a	first, second and third anal veins	ax.c	axillary cord
aepm.	anepimeron	c.	costa
aeps.	anepisternum	c.c.	coxal cavity
ant.	antenna	cd.	cardo
ant.a.	anterior arm of tentorium	cdy.	condyle

cl.	club	n.	notum
cls.	claspers of male	n.g.	notal groove
cly.	clypeus	oc.for.	occipital foramen
cn.	canthus	p.	palpus
cu ₁ cu ₂	first and second cubitus	p.gl.	paraglossa
cx.	coxa	phar.	pharynx
cx.ph.	coxal phragma	phy.scl.	phryngeal sclerite
d.rd.	diagonal ridge of scutum	pl.a.	pleural arm—entopleurum
dor.a.	dorsal arm of tentorium	pn.	pronotum
e.	eye	pn.d.	pronator disc.
ely.	elytra	p.n.p.	posterior notal wing process
ent.d.	entodorsum	p.n.r.	post notal ridge
ent.ster.	entosternum	post.a.	posterior arm of tentorium
epi.	epipharynx	post.ph.	postphragma
epm.	epimeron	pp.sm.	posterior plate of submentum
eps.	episternum	pptm.	preparapterum
es.aph.	entosternal apophysis	praes.	praescutum
f.	femur	praes.ph.	praescutal phragma-mesotergum
fac.	facet	prs. ph.	praescutal phragma-metatergum
fc.	furca	pro. ster.	prosternum
fr.	front	pss.	postscutellum
fu.	funicle	r.	ridge
ful.hyp.	fulcrum hypopharyngeum	rd.	radius
g.	gena	s.	scape
gal.	galea	sc.	subcosta
gl.	glossa	scl.	scutellum
gu.	gula	sct.	scutum
hyp.	hypopharynx	scl.red.	reduplication of scutellum
nf. pl.	inferior plates	sp.	spiracle
kepm.	katapimeron	sq. pl.	squama palpigera
keps.	katapisternum	st.	stipes
la.	lateral arm of entosternum	sup.pl.	superior plate
labi.	labium	t.	tibia
labr.	labrum	tar.	tarsus
lac.	lacina	te.	telum
post.a.	posterior arm of tentorium	t.cl.	tarsal claw
m.	mentum	tent.	tentorium
md.	medius	tn.	trochantin
m.d.	muscle disc.	tr.	trochanter
mand.	mandible	v.	vertex
max.	maxilla	w.p.	wing process
max.pf.	maxillary palpi	1-9	abdominal segments
memb.	membrane	1 ax.	first axillary
mo.	molar	2 ax.	second axillary
ms. ster.	mesosternum	3 ax.	third axillary
mt.ster.	metasternum	4 ax.	fourth axillary.

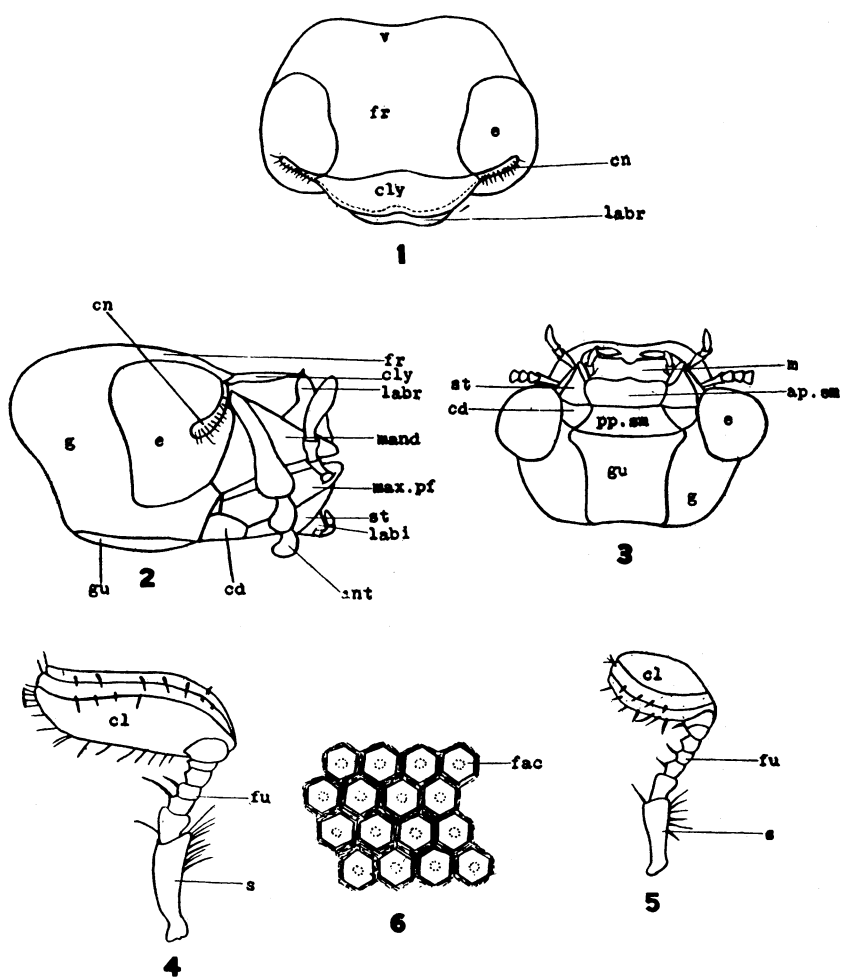


PLATE I

- Fig. 1. Front view of head.
 Fig. 2. Lateral view of head.
 Fig. 3. Ventral view of head.
 Fig. 4. Antenna of male.
 Fig. 5. Antenna of female.
 Fig. 6. Facets of the compound eye.

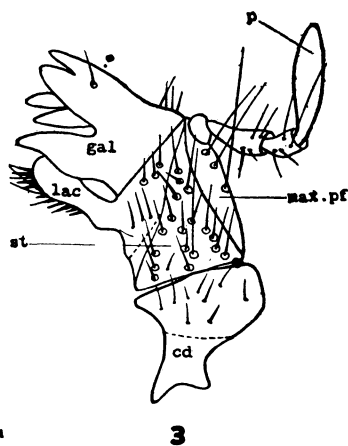
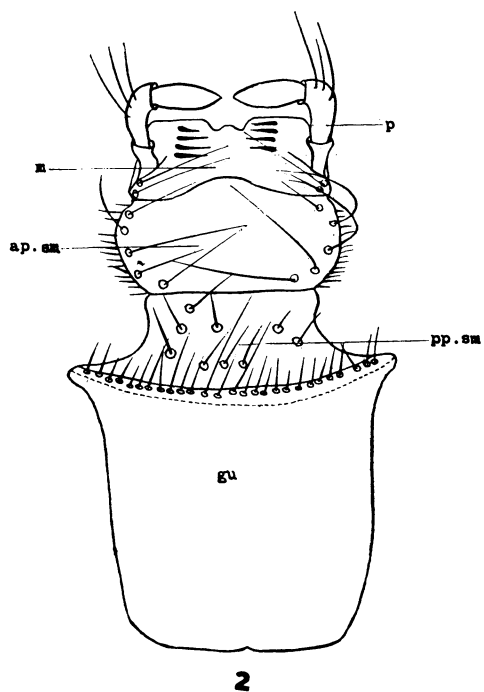
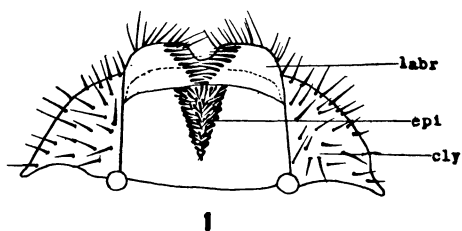


PLATE II

Fig. 1. Epipharynx and internal aspect of clypeus and labrum.

Fig. 2. Gula and Labium.

Fig. 3. Left maxilla.

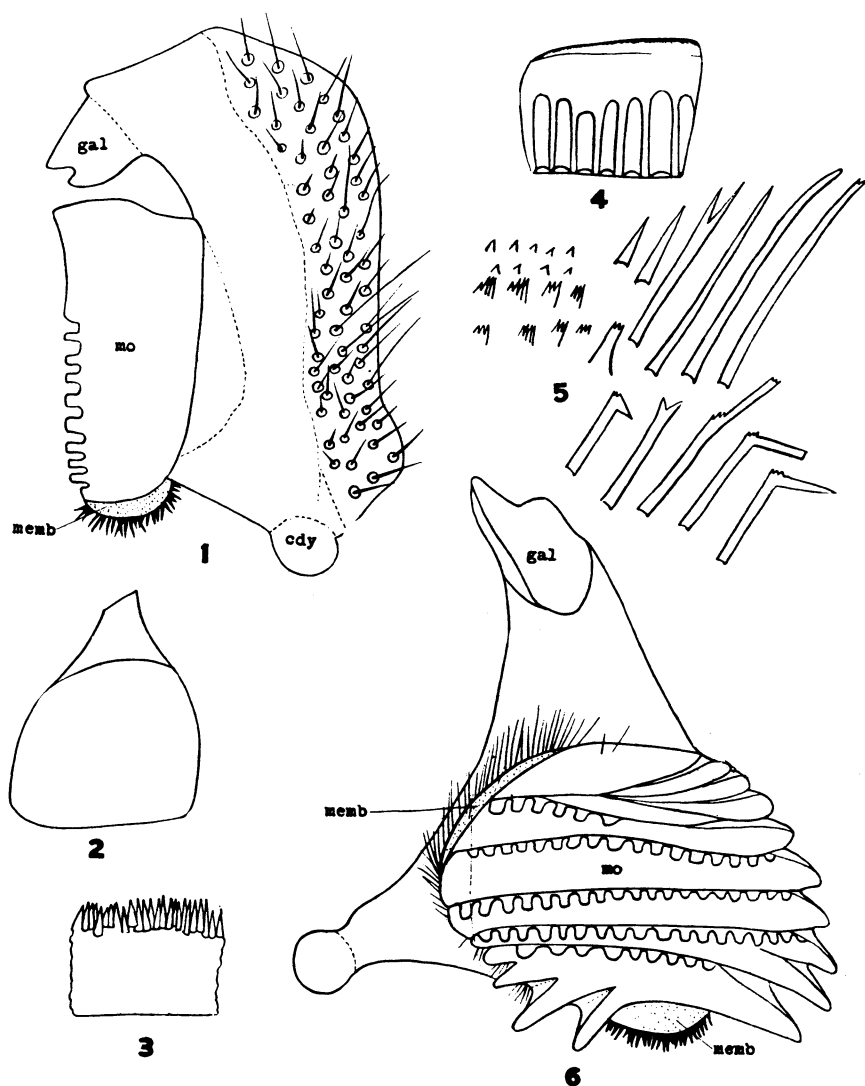


PLATE III

- Fig. 1. Side view of right mandible.
 Fig. 2. Apodeme of mandible.
 Fig. 3. Membrane and hairs at base of mandible.
 Fig. 4. Portion of cross section thru molar.
 Fig. 5. Hairs and setae from upper membrane of mandible.
 Fig. 6. Inner surface of mandible.

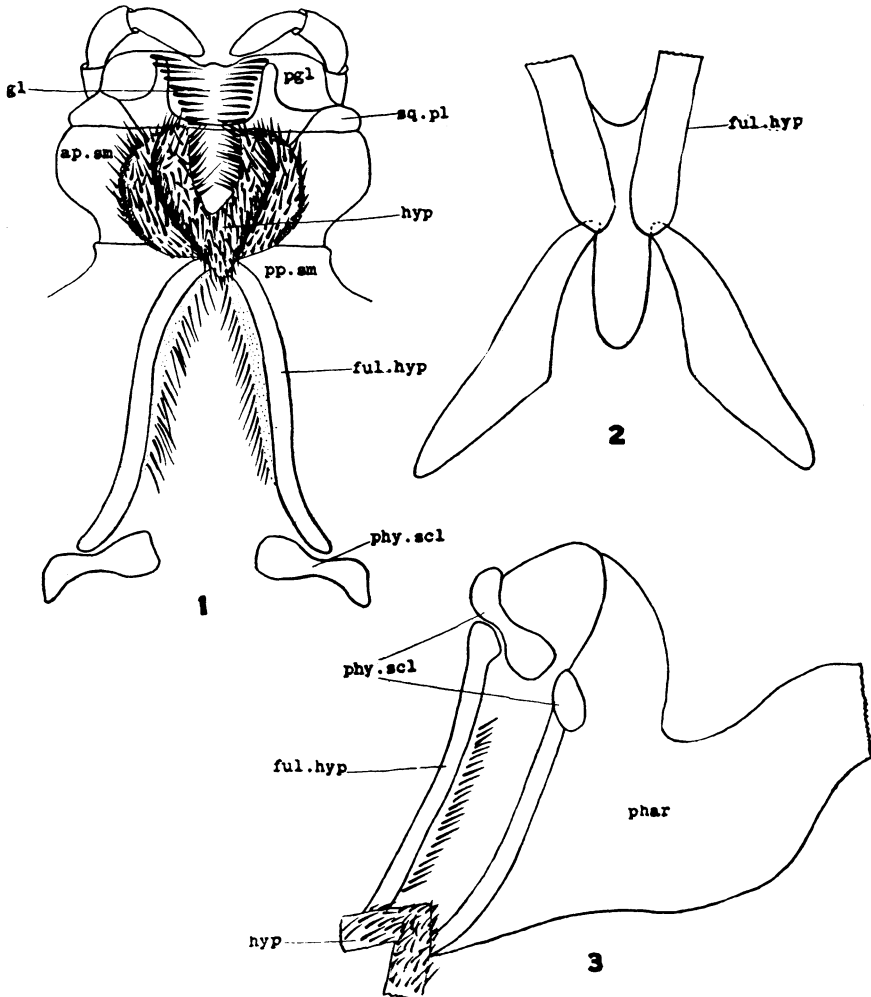


PLATE IV

- Fig. 1. Labium from within showing hypopharynx and fulcrum hypopharyngeum.
 Fig. 2. Junction of arms of fulcrum hypopharyngeum, ventral aspect.
 Fig. 3. Lateral view showing relation of fulcrum hypopharyngeum to the pharynx.

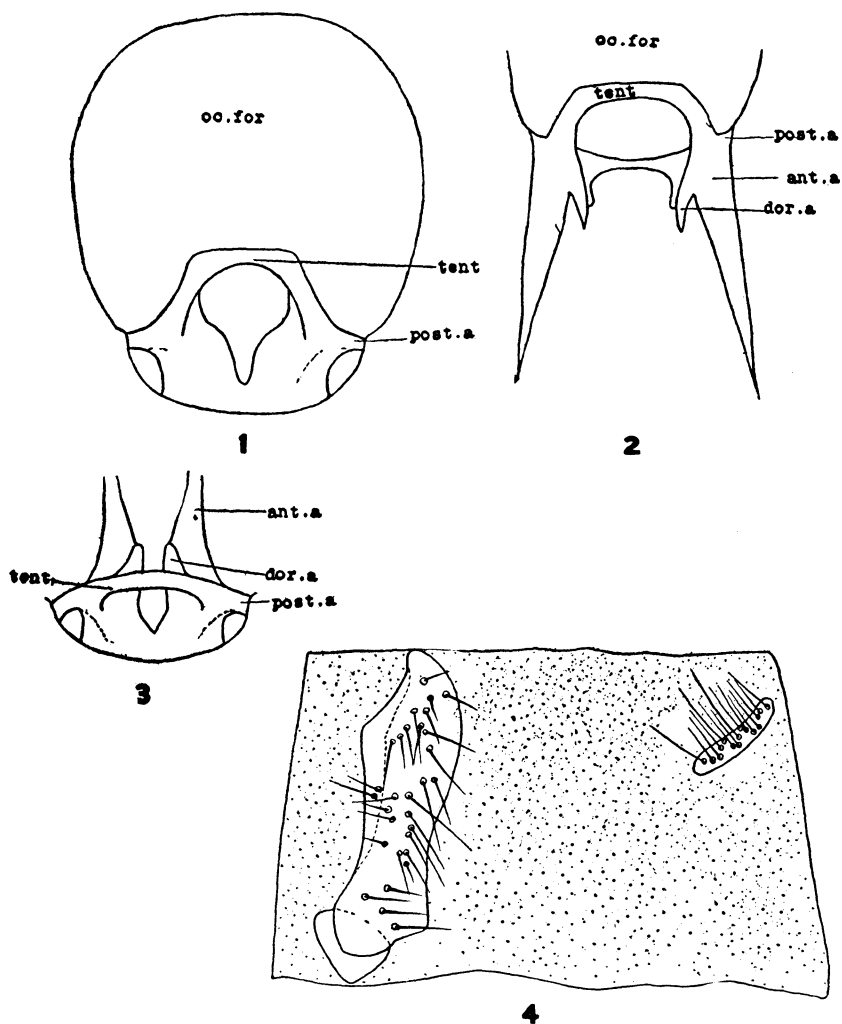


PLATE V

- Fig. 1. Tentorium—looking through occipital foramen.
 Fig. 2. Anterior view of tentorium.
 Fig. 3. Dorsal view of tentorium.
 Fig. 4. Left side of cervicum (dorsal margin to the right).

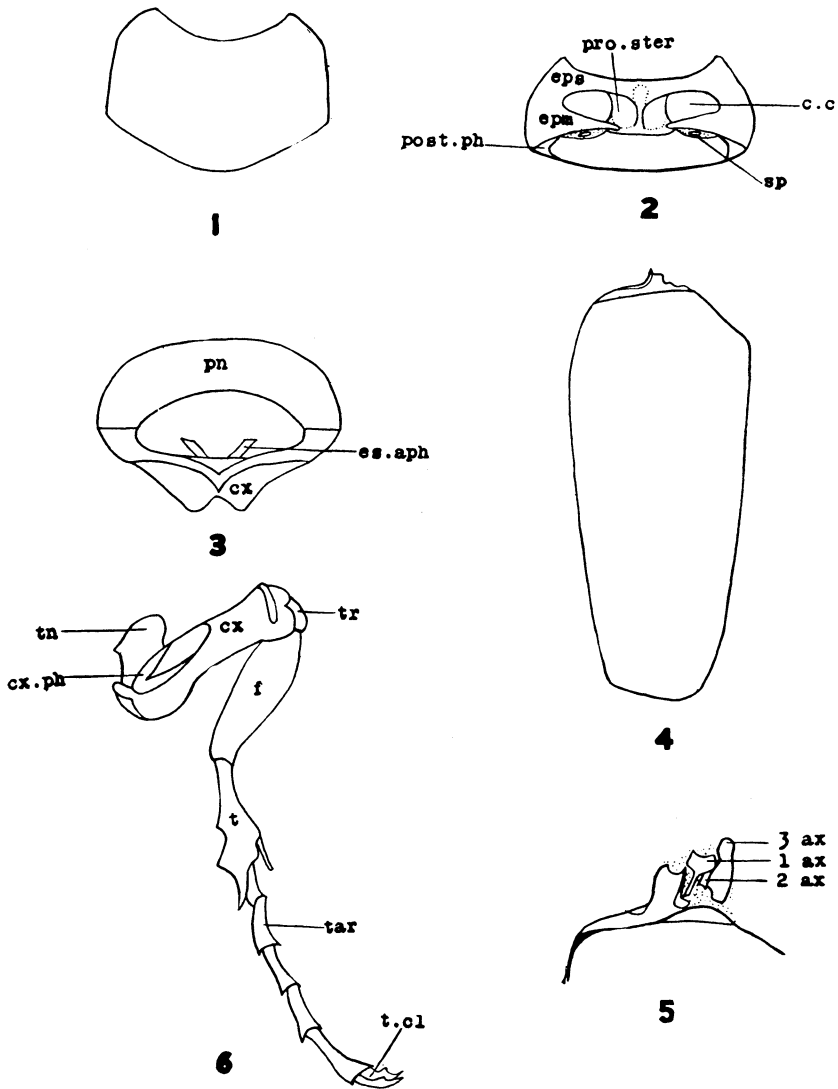


PLATE VI

- Fig. 1. Dorsal view of prothorax.
 Fig. 2. Ventral view of prothorax—coxae removed.
 Fig. 3. Anterior aspect of prothorax.
 Fig. 4. Left elytron.
 Fig. 5. Articulation of elytron.
 Fig. 6. Right prothoracic leg.

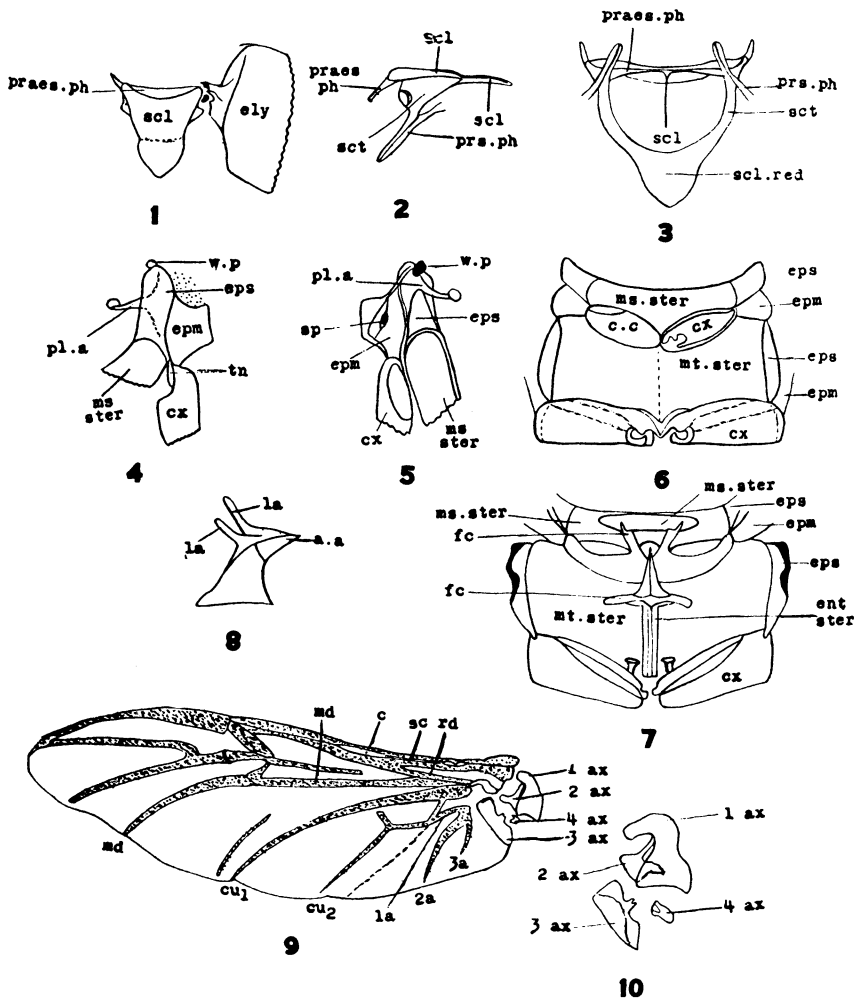


PLATE VII

- Fig. 1. Dorsal view of mesothorax with portion of right elytron.
 Fig. 2. Left lateral aspect of mesothoracic tergum.
 Fig. 3. Internal aspect of mesothoracic tergum.
 Fig. 4. Left mesopleuron, external aspect, coxa ex situ to show trochantin.
 Fig. 5. Left mesopleuron, internal aspect.
 Fig. 6. Meso- and metasterna, external aspect.
 Fig. 7. Meso- and metasterna, internal aspect.
 Fig. 8. Metathoracic endosternum.
 Fig. 9. Metathoracic wing.
 Fig. 10. Axillary sclerites of the metathoracic wing.

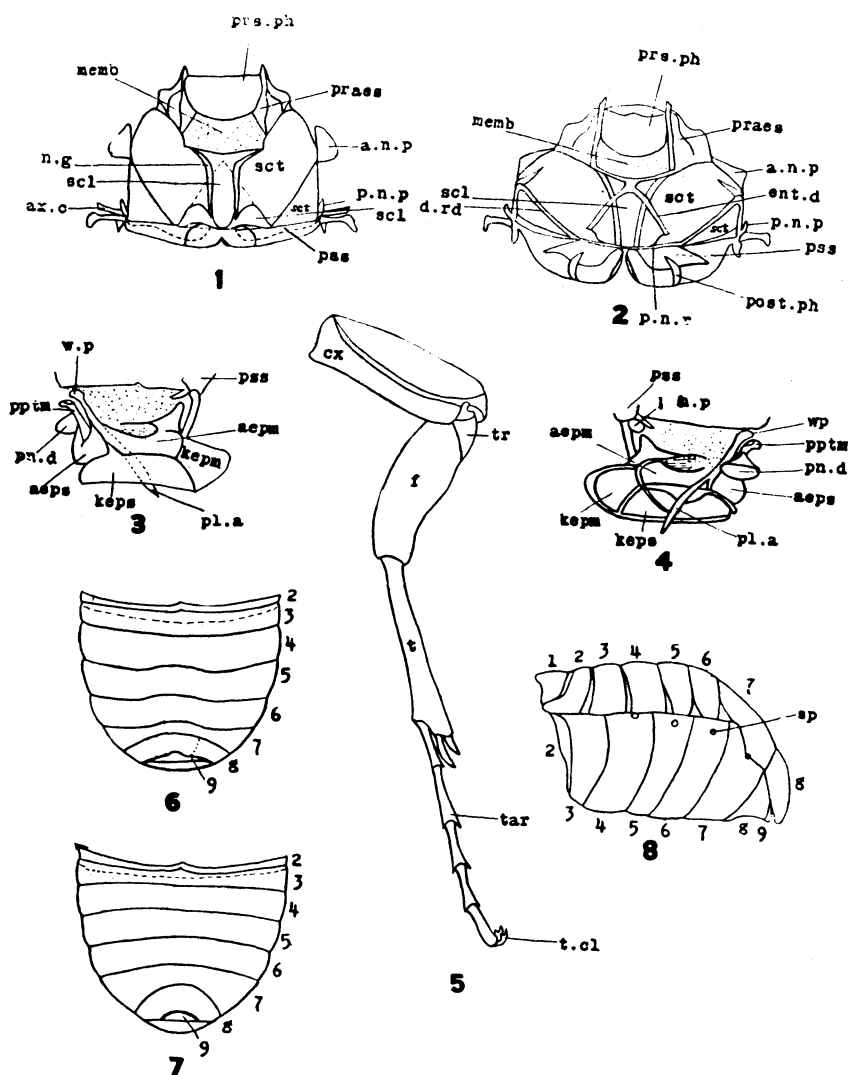


PLATE VIII

- Fig. 1. Metatergum, external aspect.
 Fig. 2. Metatergum, internal aspect.
 Fig. 3. Left metapleuron, external aspect.
 Fig. 4. Left metapleuron, internal aspect.
 Fig. 5. Right metathoracic leg.
 Fig. 6. Ventral aspect of abdomen, male.
 Fig. 7. Ventral aspect of abdomen, female.
 Fig. 8. Left lateral aspect of abdomen, male.

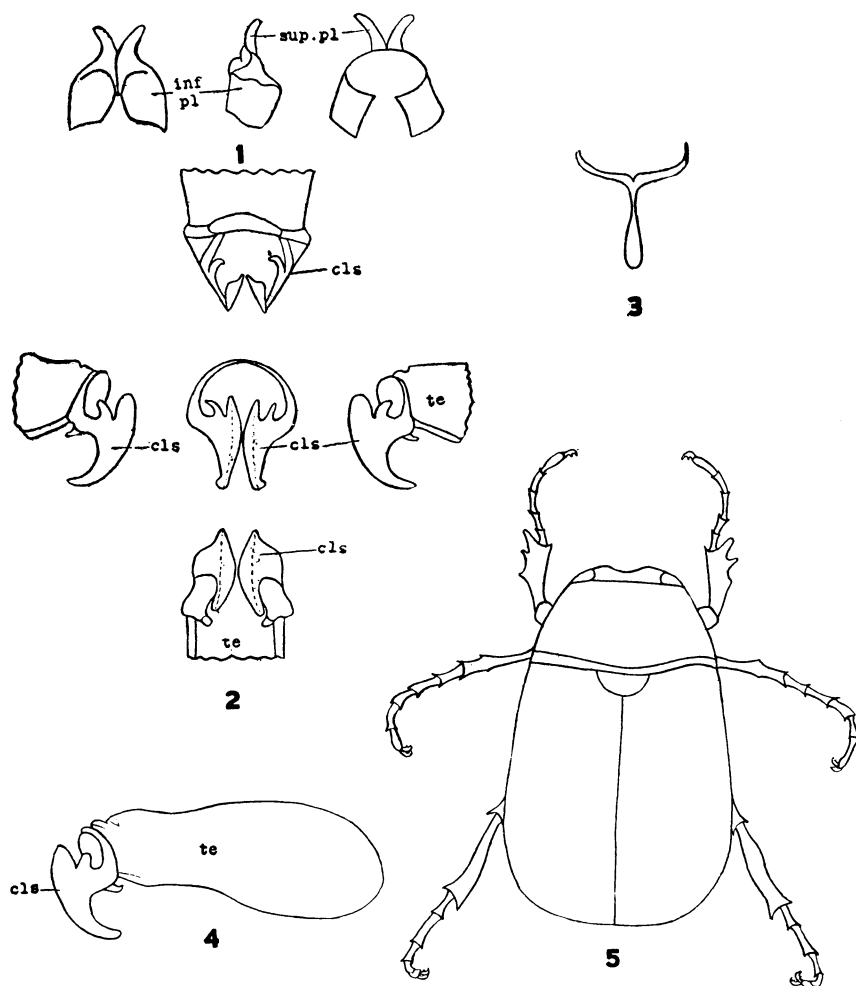


PLATE IX

- Fig. 1. Female genitalia, dorsal, ventral and lateral aspects.
 Fig. 2. Male genitalia, arranged perspective.
 Fig. 3. Y-shaped supporting structure of cloaca and telum.
 Fig. 4. Male genital organ with telum in place.
 Fig. 5. Dorsal aspect of *Lachnosterna crassissima*.